

NOAA SECTORAL APPLICATIONS RESEARCH PROGRAM (SARP)

PROJECT ANNUAL REPORT (DRAFT)

PROJECT TITLE

Use of Intra-seasonal and Seasonal Forecasts to Reduce Risk in Regional Public Water Supply Management

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July 2008 – March 2009

I. PRELIMINARY MATERIALS

A Project Abstract

Florida's economic and social development over the past several decades has been fueled by its climate and abundant water resources. Increased population, rapid urban development, large agricultural water demands, and the need to protect natural resources, however, have led to conflicts between urban, agricultural, industrial, and natural system water users. Freshwater withdrawals in Florida are expected to grow from approximately 8.2 billion gallons per day (bgd) in 2000 to more than 9.3 bgd in 2020 in order to meet the needs of a population that is expected to increase from 16 to 22 million. Weather and climate variability has a major influence on demand and availability of water. Recent advances in short- and medium-range forecasts, and statistical downscaling techniques, indicate that these forecasts could be used to help water resource managers provide a more reliable, environmentally-sound supply of water. Although there is strong interest by water resource managers in the state, there is also considerable uncertainty in the risks of incorporating forecasts into their decision making processes. Questions by water managers include both how to replace historical information with forecasts as well as what new exposures to risk are possible in embracing forecast-based information.

The aim of this proposed project is to characterize the value, uncertainties and risks associated with the use of probabilistic precipitation forecasts for water management decisions. Southwest Florida, which includes the heavily populated Tampa Bay area, arguably has the most intense competition for water resources among urban, agricultural and ecological users. The major water resource decision makers in this area are Tampa Bay Water, the largest public water supplier in the region, and the Southwest Florida Water Management District (SWFWMD), which has the responsibility of issuing permits to users of surface and aquifer water sources. Two objectives will guide our research: 1) Develop and implement a prototype that uses weekly probabilistic forecasts with a 1-month forecast horizon in Tampa Bay Water's processes of forecasting demand and making source water allocation decisions, and 2) Quantify the uncertainty, reliability, and risk associated with using probabilistic forecasts in Tampa Bay Water's decision making. The first objective will focus on a 1-week to 1-month operational time-scale. The second objective will focus on both a) the operational time-scale, and b) a 1 to 24 month planning time-scale (and will complement the 1 to 24 month probabilistic precipitation forecasts that we are currently developing for Tampa Bay Water). Tampa Bay Water makes decisions on a weekly basis regarding how to meet their customers' water demand by rotating and apportioning among existing sources to minimize cost and environmental impacts while maximizing reliability. They have expressed strong interest in forecast use, but want to understand the risks of doing so. We will use analog techniques and Model Output Statistics (MOS) to incorporate short- and medium-range probabilistic forecasts into the decision models used by Tampa Bay Water and estimate risks and costs relative to using mean climate inputs in their decision process. Results of this research will be communicated to decision-makers and stakeholders using mechanisms that they routinely use, and we will summarize results on AgroClimate.org, the web-based climate information and decision support system developed by the Southeast Climate Consortium.

B Objective of Research Project

The goal of this project is to develop information needed by a public water supplier in a large urban area in Southwest Florida. Specifically, we aim to characterize the value, uncertainties and risks associated with the use of probabilistic precipitation forecasts for decisions on water allocations. The research will involve decision makers throughout the project and build on the operational and planning time-scale decision processes already in place in Tampa Bay Water, the major public water supplier in that area, and contribute to improved regional water management. The prototype methodology that incorporates the use of precipitation forecasts will be made available to Tampa Bay Water for its own evaluation and use. Toward this goal we have established the following two objectives: 1) Develop and implement a prototype methodology for incorporating 1-week to 1-month forecasts into Tampa Bay Water's processes of forecasting water demand and making source allocation decisions in Southwest Florida; and 2) Implement a comparative decision/risk analysis on Tampa Bay Water decision algorithms using historical- and forecast-based climate information for both short-term (1-week to 1-month) and medium-term (1-month to 24-month) time frames.

This project has two main objectives: 1) Develop and implement a prototype methodology for incorporating precipitation forecasts into Tampa Bay Water's decision making processes, and 2) Implement a comparative decision/risk analysis on Tampa Bay Water decision algorithms using historical- and forecast-based climate information.

For objective 1) we will focus on developing precipitation forecasts for the short-term operational interval (1-week to 1-month) and examine how reliability can be improved, or risk can be reduced, by incorporating precipitation forecasts into the short-term operational models employed by Tampa Bay Water. One-week to 1-month forecasts for individual rain gauges will be generated using: a) the archive of 1-14 day retrospective forecasts (reforecasts) maintained by the ESRL/PSD using a static version of NCEP's global forecasting system (GFS) and blended with a climatological or ENSO-conditioned climatological forecast (weeks 3 and 4), and b) Similar available forecast products such as the 5-day Quantitative Precipitation Forecast (QPF) issued by the Hydrometeorological Prediction Center (HPC) and blended with a climatological or ENSO conditioned climatological forecast for day 6 to the end of the month. Post-processing of both the forecast datasets will be conducted using both analog and model output statistic (MOS) techniques. The skill of these forecasts will be evaluated relative to current practice by Tampa Bay Water (assuming average rainfall or persistence of recent rainfall). Forecasts showing greater skill than current practice will be integrated into the suite of hydrologic and demand forecast models used by Tampa Bay Water for operational (1-week to 1-month) decision making.

In objective 2) we will focus on scenarios for both the 1-week to 1-month short-term operational forecast time-scale and the 1 to 24 month planning time-scale. In close cooperation with Tampa Bay Water staff, we will pose alternative water management scenarios and utilize multi-criteria decision analysis (MCDA). The scenarios and MCDA methods will use selected stakeholder and manager value judgments to evaluate various scenarios (both simulated with and without using weather and climate forecasts) to quantify the uncertainty, risk, and potential increase in reliability that can be achieved by integrating forecasts into Tampa Bay Water's source rotation decision making.

The key beneficiaries of this work will be water utility managers who must make source rotation decisions to maximize system reliability while minimizing environmental impact. Our collaborator, Tampa Bay Water, will benefit directly from this work. We anticipate our results

- C Approach (including methodological framework, models used, theory developed and tested, project monitoring and evaluation criteria) include a description of the key beneficiaries of the anticipated findings of this project (e.g., decision makers in a particular sector/level of government, researchers, private sector, science and resource management agencies)

D Description of any matching funds/activities used in this project

For this project we have been able to take advantage of our previously existing and on-going relationship with Tampa Bay Water technical staff. The benefit we have received has been in the form of the time spent by technical staff at Tampa Bay Water on this project and on a similar project the PIs have which is funded directly from Tampa Bay Water.

II. ACCOMPLISHMENTS

- A. Brief discussion of project timeline and tasks accomplished. Include a discussion of data collected, models developed or augmented, fieldwork undertaken, or analysis and/or evaluation undertaken, workshops held, training or other capacity building activities implemented.

Objective 1:

- Short-term, operational models of streamflow, groundwater levels, and demand have been obtained from Tampa Bay Water.
- The historical rainfall database, which will be used to evaluate forecast products, has been obtained from Tampa Bay Water.
- Initial code-writing of post-processing of reforecasts has begun. Preliminary results of this work will be presented at the Southeast Climate Consortium Program Review (May 5-7, 2009).
- The GroundWater Artificial Neural Network (GWANN) model used by Tampa Bay Water to forecast groundwater levels at a weekly timestep and a 1-month forecast horizon has been evaluated and found to be relatively insensitive to rainfall. Thus, improved rainfall forecasts will have very little improvement on forecasted groundwater levels.

Objective 2:

- We have begun discussions with Tampa Bay Water staff on potential scenarios, constraints, opportunities for forecast information, and information feedbacks in their decision making process.
- We have begun discussions with Tampa Bay Water decision makers on their personal valuation of different decision criteria.
- We anticipate both of the above items to be iterative, please find attached preliminary graphics we have designed from our initial work. These graphics are being used to share our current thinking among all project staff.

B. Summary of findings, including their potential or actual implications for efforts to develop applications, methods, and science-based decision support capacity/systems and to foster sustainable resource management and vulnerability reduction.

The GroundWater Artificial Neural Network (GWANN) model used by Tampa Bay Water to forecast groundwater levels at a weekly time-step and a 1-month forecast horizon has been evaluated and found to be relatively insensitive to rainfall. Thus, improved rainfall forecasts will have very little improvement on forecasted groundwater levels. We anticipate models of 1-week to 1-month water demand and streamflow (and its relationship to stream salinity) to exhibit greater sensitivity to forecasted rainfall.

C. List of any reports, papers, publications or presentations arising from this project; please send any reprints of journal articles as they appear in the literature. Indicate whether a paper is formally reviewed and published.

None at this time.

D. Discussion of any significant deviations from proposed workplan (e.g., shift in priorities following consultation with program manager, delayed fieldwork due to late arrival of funds, obstacles encountered during the course of the project that have impacted outcome delivery).

Our progress has been delayed somewhat due to late arrival of funds and a longer than anticipated time required to secure our post-doctoral research associate's visa. The visa delay was due partially to timing (the University Christmas break) and partially due to a backlog at the University's international office. We initially expected our post-doctoral research associate to start in January or early February of 2009. However this has been delayed to April of 2009.

E. Where appropriate, describe the climate information products and forecasts considered in your project (both NOAA and non-NOAA); identify any specific feedback on the NOAA products that might be helpful for improvement. (bulleted response)

- Central to this project is the availability of the 1-14 day reforecast archived maintained by ESRL/PSD
- Other available forecast products, such as the 5-day Quantitative Precipitation Forecast (QPF) issued by the Hydrometeorological Prediction Center (HPC) will be evaluated
- The monthly ENSO climatological forecasts will evaluate phase definitions of CPC and COAPS at FSU to determine the most appropriate for use in the study region.

III. GRAPHICS: PLEASE INCLUDE THE FOLLOWING GRAPHICS AS ATTACHMENTS TO YOUR REPORT

A. One Power point slide depicting the overall project framework/approach/results to date

B. If appropriate, additional graphic(s) or presentation(s) depicting any key research results thus far

C. Photographs (if easy to obtain) from fieldwork to depict study information (if applicable).

IV. WEBSITE ADDRESS FOR FURTHER INFORMATION (IF APPLICABLE)

V. ADDITIONAL RELEVANT INFORMATION NOT COVERED UNDER THE ABOVE CATEGORIES.

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